(1)

USAARL Report 89-3

Inhalation Anesthesia in the Chinchilla

By

C.E. Hargett, Jr.

Research Foundation

State University of New York at Plattsburgh

and

Jeffrey W. Record

Research Systems Division

January 1989

167 ~~148~~

United States Army Aeromedical Research Laboratory
Fort Rucker, Alabama 36362-5292

Notice

Qualified requesters

Qualified requesters may obtain copies from the Defense Technical Information Center (DTIC), Cameron Station, Alexandria, Virginia 22314. Orders will be expedited if placed through the librarian or other person designated to request documents from DTIC.

Change of address

Organizations receiving reports from the U.S. Army Aeromedical Research Laboratory on automatic mailing lists should confirm correct address when corresponding about laboratory reports.

Animal use

In conducting the research described in this report, the investigators adhered to the Guide for care and use of laboratory animals, as promulgated by the Committee on Care and Use of Laboratory Animals of the Institute of Laboratory Resources Commission on Life Sciences, National Academy of Sciences-National Research Council.

Disposition

Destroy this report when it is no longer needed. Do not return it to the originator.

Disclaimer

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citation of trade names in this report does not constitute an official Department of the Army endorsement or approval of the use of such commercial items.

Reviewed:

Bruce C. Leibrecht

BRUCE C. LEIBRECHT, Ph.D.
LTC, MS
Director, Sensory Research Division

J D LaMothe

J. D. LaMOTHE, Ph.D.
COL, MS
Chairman, Scientific Review Committee

Released for publication:

David H Karney

DAVID H. KARNEY
Colonel, MC
Commanding

UNCLASSIFIED
SECURITY CLASSIFICATION OF

AD-A205 412

REPORT DOCUMENTATION PAGE — Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S): USAARL Report No. 89-3	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION: U.S. Army Aeromedical Research Laboratory — 6b. OFFICE SYMBOL (If applicable): SGRD-UAS-AS	7a. NAME OF MONITORING ORGANIZATION: U.S. Army Medical Research and Development Command
6c. ADDRESS (City, State, and ZIP Code): Fort Rucker, AL 36362-5292	7b. ADDRESS (City, State, and ZIP Code): Fort Detrick Frederick, MD 21701-5012
8a. NAME OF FUNDING/SPONSORING ORGANIZATION — 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO. 61102A; PROJECT NO. 3M161102BS15; TASK NO. CB; WORK UNIT ACCESSION NO. 282

11. TITLE (Include Security Classification)
Inhalation Anesthesia in the Chinchilla (U)

12. PERSONAL AUTHOR(S)
C. E. Hargett, Jr. and Jeffrey W. Record

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM ______ TO ______	1989 January	17

16. SUPPLEMENTARY NOTATION

17. COSATI CODES

FIELD	GROUP	SUB-GROUP
20	01	
24	07	

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Chinchilla, Nonrebreathing, Isoflurane, Semiclosed, Halothane

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Inhalation anesthesia techniques which successfully induce surgical anesthesia in Chinchilla villidera are described and compared. Isoflurane-nitrous oxide and halothane-nitrous oxide delivered by a nonrebreathing system are compared to halothane-nitrous oxide delivered by a semiclosed system. Thirty six laboratory raised adult chinchillas in three groups were used in this study. All achieved surgical anesthesia with no deaths. Time to loss of righting reflex, time to surgical anesthesia, duration of surgical anesthesia, and time from end of surgical anesthesia until standing unaided were recorded. Findings indicate that isoflurane-nitrous oxide delivered by a nonrebreathing system provides superior results.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION
22a. NAME OF RESPONSIBLE INDIVIDUAL: Chief, Scientific Information Center	22b. TELEPHONE (Include Area Code): (205) 255-6907 — 22c. OFFICE SYMBOL: SGRD-UAX-SI

DD Form 1473, JUN 86 — Previous editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

Acknowledgments

This work was supported in part by U.S. Army Medical Research and Development Command (USAMRDC) Contract Number DAMD17-86-C-6139.

C.E. Hargett, Jr., an employee of the Research Foundation, State University of New York at Plattsburgh, is assigned fulltime at the U.S. Army Aeromedical Research Laboratory (USAARL) as part of the above contract.

The authors wish to thank Mrs. Linda S. Barlow for her valuable statistical assistance and Mrs. Margo Koehler for her valuable editorial assistance.

Table of contents

List of tables

This page intentionally left blank.

Introduction

Halothane (halothane U.S.P.) has been used successfully to induce surgical anesthesia in the chinchilla (<u>Chinchilla villidera</u>). The Acoustical Sciences Branch, Sensory Research Division, U.S. Army Aeromedical Research Laboratory (USAARL), has used halothane as one of its methods of surgical anesthesia for monauralizations of the chinchillas in auditory research (Hargett et al., 1988).

For monauralization surgery in chinchillas, inhalation anesthesia has a number of advantages. Chief among these is the agents are eliminated mostly through the lungs, so recovery from anesthesia does not rely on redistribution within the body and detoxification mechanisms (Lumb and Jones, 1973). Inhalation anesthesia requires specialized equipment, but it is the only technique that allows for control of anesthetic depth and surgical anesthesia duration.

The rapid induction of and rapid recovery from halothane anesthesia, when compared to injectables used for surgical anesthesia in chinchillas, has been clearly established (Hargett et al., 1988). Experience at USAARL has shown that 20 to 25 minutes of surgical anesthesia is sufficient for most procedures. For this reason, we have used a mixture of halothane and nitrous oxide in the past to anesthetize our chinchillas for surgery. Halothane is a halogenated hydrocarbon that produces a potent nonexplosive anesthesia agent (Deutsch, 1971).

Isoflurane (Forane^{R}), a nonflammable liquid, is a new inhalation general anesthetic. Induction of and recovery from isoflurane anesthesia are rapid. The level of anesthesia may be changed rapidly with isoflurane. Nitrous oxide reduces the inspiratory concentration of isoflurane required to reach a desired level of anesthesia and may reduce the arterial hypotension seen with isoflurane alone. In contrast to halothane, isoflurane does not sensitize the myocardium to exogenously administered epinephrine in the dog. Surgical levels of anesthesia may be sustained with a 1.0 - 2.5 percent concentration when nitrous oxide is used concomitantly. An additional 0.5 - 1.0 percent may be required when isoflurane is given using oxygen alone (Anaquest, 1987).

The present study was undertaken to compare halothane in a semi-closed system, halothane in a nonrebreathing system and isoflurane in a nonrebreathing system in the chinchilla.

Methods and procedures

This study used 26 healthy adult chinchillas of both sexes from the USAARL issue colony. Data from an additional 10 chinchillas were obtained from a previous study (Hargett et al., 1988).

Individual stainless steel laboratory cages (483 mm x 607 mm x 203 mm) were used as housing for the subjects. They were provided with a commercial chinchilla ration* and water ad libitum. Weights ranged from 459 grams to 790 grams with a mean weight of 584 grams and a median weight of 570 grams. Ages ranged from 13 to 22 months. The chinchillas were not deprived of food or water prior to the experiment and were returned to their cages upon being able to stand unaided.

Animals were assigned randomly to each group. Each subject was anesthetized to surgical depth by the method of anesthesia for its assigned group. Surgical depth is defined as the loss of righting reflex followed by the loss of toepinch reflex and is corroborated by subjectively evaluating the chinchilla's overall appearance and vital signs. The following data were collected on each subject: respiration rates, time to loss of righting reflex, time to loss of toepinch reflex, time from removing the anesthetic to return of toepinch reflex, and time from removing the anesthetic to standing unaided. The time at surgical depth was limited to 20 minutes. This is neither a minimum nor maximum for the techniques tested, but merely a convenient benchmark.

The methods used to induce surgical anesthesia were:

Group I: Halothane and nitrous oxide administered by face mask in a semiclosed system.

Group II: Halothane and nitrous oxide administered by face mask in a nonrebreathing system.

Group III: Isoflurane and nitrous oxide administered by face mask in a nonrebreathing system.

Flow rates for Group I were the traditional settings using the semiclosed delivery system. This was determined to be more total gas flow than necessary for the nonrebreathing delivery system. The ratio of nitrous oxide to oxygen for Groups II and III remained the same as Group I with the flow rates scaled down to minimize waste when using the nonrebreathing system.

All times were taken with a stopwatch and recorded to the nearest minute and second.

Group I

Ten chinchillas with a mean weight of 522.6 grams were anesthetized with a semiclosed system of inhalation anesthesia. These subjects actually were run as part of an earlier study reported by

---

* See Appendix A.

Hargett et al., (1988). The chinchillas were placed on the surface of the anesthesia machine and their heads inserted into the mask. They were held with their heads in the mask until loss of righting reflex occurred. A 4 percent setting of halothane, with a flow rate of 4 liters per minute of nitrous oxide and 2 liters per minute of oxygen, was used for induction. When the toe-pinch reflex was no longer present, the chinchilla was removed from the mask, eyes were lubricated with Optivet[R] to prevent corneal drying, and subject was returned to the mask. The loss of toepinch reflex was taken to be the beginning of surgical anesthesia. The chinchilla was maintained at surgical depth using a 2.5 percent halothane setting, with a flow rate of 2 liters per minute of nitrous oxide and 2 liters per minute of oxygen.

At the end of 20 minutes, the halothane and nitrous oxide were turned off (no flow) and the oxygen flow was maintained at 2 liters per minute. This enabled the chinchilla to return to consciousness rapidly, without complications induced by nitrous oxide (Soma, 1971).

Group II

Ten chinchillas were anesthetized using a nonrebreathing system employing a face mask. The chinchillas were placed on a padded surface, and their heads were inserted into the mask. They were restrained physically until they lost their righting reflex. A setting of 4 percent halothane, with a flow rate of 2 liters per minute of nitrous oxide and 1 liter per minute of oxygen, was employed for induction.

Upon the loss of toepinch reflex, each chinchilla was removed from the mask and a small amount of Lubrifair[R] was placed in each eye to prevent corneal drying. The subject then was returned to the mask and maintained at surgical depth for 20 minutes using a setting of 2.5 percent halothane at a flow rate of 1.5 liter per minute of both nitrous oxide and oxygen.

At the end of the 20 minutes at surgical depth, the halothane and nitrous oxide were turned off and the oxygen flow maintained at 3 liters per minute. When the subject was able to stand unaided, it was returned to its cage.

Group III

Sixteen chinchillas were anesthetized using a nonrebreathing system employing a face mask. Each chinchilla was placed on a padded surface, and its head was inserted into the mask. Each subect was restrained physically until loss of righting reflex was

observed. A setting of 5 percent isoflurane, with a flow rate of 2 liters per minute of nitrous oxide and 1 liter per minute of oxygen, was employed for induction.

Upon the loss of toepinch reflex, each subject was removed from the mask and a small amount of Lubrifair[R] was placed in each eye to prevent corneal drying. The subject then was returned to the mask and maintained at surgical depth for 20 minutes. A total of 3 animals were tested using 2 percent isoflurane, 10 were tested using 1.5 percent isoflurane, 2 were tested using 1.0 percent isoflurane, and 1 was tested using 0.5 percent isoflurane. In each instance, the flow rate was 1.5 liters per minute of nitrous oxide and 1.5 liters per minute of oxygen. Based on the initial trials at the various settings, we concluded 1.5 percent isoflurane would provide satisfactory anesthesia at an economical cost. Thus, this setting was selected for the primary focus of our isoflurane work. Although data were taken at the other percentages as indicated, these findings are not discussed in this report.

At the end of the 20 minutes at surgical anesthesia, these subjects were handled the same as those in Group II.

Results and Discussion

The times to loss of righting reflex are shown in Table 1. These data (time in seconds) for the nonrebreathing system with either inhalation anesthetic agent are shorter than the semiclosed system. The analysis of variance revealed significant differences (ã = .05) between groups. The *a posteriori* analysis revealed significant differences in mean time to loss of righting reflex between the isoflurane and halothane groups delivered with the nonrebreathing system and showed a significant difference between those groups and the group using halothane delivered with the semiclosed system.

Table 1.
Time to loss of righting reflex in seconds

	Group I	Group II	Group III
Median	128.5	63.5	42.5
Range	46-170	50-105	30-50
Mean	124.1	67.8	41.0
S.D.	34.3	16.9	9.1

Group I = Halothane, semiclosed system, mask
Group II = Halothane, nonrebreathing system, mask
Group III = Isoflurane, nonrebreathing system, mask

The times to loss of toepinch reflex are shown in Table 2. Loss of toepinch reflex in the group receiving isoflurane delivered through a nonrebreathing system averaged over 110 seconds faster

than the group receiving halothane delivered through a nonrebreathing system and over 250 seconds faster than the group receiving halothane delivered through a semiclosed system. The analysis of variance revealed significant differences (ā = .05) between groups.

Table 2.
Time to loss of toepinch reflex in seconds

	Group I	Group II	Group III
Median	332.5	167.5	60.0
Range	150-402	130-220	45-90
Mean	308.2	168.9	58.0
S.D.	72.7	29.0	13.6

Group I = Halothane, semiclosed system, mask
Group II = Halothane, nonrebreathing system, mask
Group III = Isoflurane, nonrebreathing system, mask

The times from turning the anesthesia machine off until the return of the toepinch reflex are shown in Table 3. The end of surgical anesthesia was determined by the return of the toepinch after delivery of the anesthetic agent was terminated. The analysis of variance revealed significant differences (ā = .05) between groups. The <u>a posteriori</u> analysis revealed a significant difference between the isoflurane group and the semiclosed group, with the halothane delivered with a nonrebreathing system having no honestly significant difference from either of the other two groups.

Table 3.
Time from machine off to return of toepinch reflex in minutes

	Group I	Group II	Group III
Median	4.5	4.3	3.4
Range	4.0-6.0	3.0-7.0	1.5-5.5
Mean	4.6	4.5	3.4
S.D.	0.7	1.3	1.2

Group I = Halothane, semiclosed system, mask
Group II = Halothane, nonrebreathing system, mask
Group III = Isoflurane, nonrebreathing system, mask

The time in minutes to standing unaided is a major consideration for choosing an anesthetic agent and a delivery system. Data in Table 4 shows this measure averaged 3.2 minutes faster with the isoflurane delivered with the nonrebreathing system than the halothane delivered with the nonrebreathing system and 6.6 minutes faster than the halothane delivered with the semiclosed system.

The analysis of variance revealed significant differences (ã = .05) between groups.

Table 4.
Time from return of toepinch to standing unaided in minutes

	Group I	Group II	Group III
Median	7.3	3.3	1.4
Range	4.2-16.0	1.3-13.2	0.8-2.9
Mean	8.2	4.8	1.6
S.D.	3.2	3.8	0.7

Group I = Halothane, semiclosed system, mask
Group II = Halothane, nonrebreathing system, mask
Group III = Isoflurane, nonrebreathing system, mask

Conclusions

Although each of the anesthetic techniques employed will successfully anesthetize the chinchilla, there are advantages and disadvantages to each technique.

Halothane using a semiclosed delivery system is unacceptable because the design of the system does not allow for proper air exchange. Because of the small tidal volume of the chinchilla, it is forced to rebreathe the unfiltered air it exhales into the hose system. Induction and recovery times are prolonged, and the animal is rebreathing toxic halothane metabolites.

Halothane using a nonrebreathing system is an acceptable choice for anesthetizing the chinchilla. The delivery system is appropriate for the size animal involved, and halothane is a potent inhalation anesthetic. Induction and recovery times were cut by approximately 40 percent by using the nonrebreathing apparatus. In addition, the equipment required readily is available in the laboratory, and the cost compared to isoflurane is low.

Isoflurane using a nonrebreathing system also is an acceptable choice. The delivery system is appropriate for the chinchilla, and isoflurane is a safe, potent anesthetic agent. Induction time was cut by approximately 40 percent, and recovery time was cut by approximately 65 percent by using isoflurane as the anesthetic agent. This agent is safer than halothane for both the animal and the operating room personnel. It is neither a carcinogen nor a hepatotoxin as is halothane. In addition, the depth of anesthesia can be changed more rapidly with isoflurane than with halothane.

The one disadvantage of isoflurane is cost: the agent is expensive, and new vaporizers would be required for its use.

We conclude the best choice for inhalation anesthesia for the chinchilla is isoflurane using a nonrebreathing deliverysystem. This system provides more rapid induction and recovery than halothane, and is safer for the animal and the personnel involved.

References

Deutsch, S. 1971. The pharmacodynamics of halothane. In The textbook of veterinary anesthesia. Soma, L.R. (ed.) Baltimore, MD: Williams and Wilkins Company.

Forane (isoflurane, USP), liquid for inhalation. 1987. Madison, Wisconsin: Anaquest.

Hargett, C.E., Jr., Lomba Gautier, I.M., Carrier, M., Jr., Landon, C.S., McConnell, I.W. and Patterson, J.H., Jr. 1988. Comparison of three anesthetics for chinchilla. Fort Rucker, AL: U.S. Army Aeromedical Research Laboratory. USAARL Report No. 88-4.

Lumb, W.V., and Jones, E.W. 1973. Veterinary anesthesia. Philadelphia, PA: Lea & Febiger.

Soma, L.R. 1971. Systems and techniques for inhalation anesthesia. In The textbook of veterinary anesthesia. Soma, L.R. (ed.) Baltimore, MD: Williams and Wilkins Company.

Appendix A

List of manufacturers

Halocarbon Laboratories, Incorporated
82 Berlews Court
Hackensack, NJ 07601
(Halothane U.S.P.)

BOC Health Care
Anaquest
Madison, WI 53713
(Forane)

Ralston Purina Company
Checkerboard Square
St. Louis, MO 63164
(Purina Chin Chow)

Burns-Biotec Laboratories, Incorporated
8536 K Street
Omaha, NE 68127
(Optivet)

Pharmafair, Incorporated
110 Kennedy Drive
Hauppauge, NY 11788
(Lubrifair)

Initial distribution

Commander
U.S. Army Natick Research
and Development Center
ATTN: Documents Librarian
Natick, MA 01760

Naval Submarine Medical
Research Laboratory
Medical Library, Naval Sub Base
Box 900
Groton, CT 05340

Commander/Director
U.S. Army Combat Surveillance
& Target Acquisition Lab
ATTN: DELCS-D
Fort Monmouth, NJ 07703-5304

Commander
10th Medical Laboratory
ATTN: Audiologist
APO NEW YORK 09180

Commander
Naval Air Development Center
Biophysics Lab
ATTN: G. Kydd
Code 60B1
Warminster, PA 18974

Naval Air Development Center
Technical Information Division
Technical Support Detachment
Warminster, PA 18974

Dr. E. Hendler
Human Factors Applications, Inc.
295 West Street Road
Warminster, PA 18974

Under Secretary of .'efense
for Research and Engineering
ATTN: Military Assistant
for Medical and Life Sciences
Washington, DC 20301

Commander
U.S. Army Research Institute
of Environmental Medicine
Natick, MA 01760

U.S. Army Avionics Research
and Development Activity
ATTN: SAVAA-P-TP
Fort Monmouth, NJ 07703-5401

U.S. Army Research and Development
Support Activity
Fort Monmouth, NJ 07703

Chief, Benet Weapons Laboratory
LCWSL, USA ARRADCOM
ATTN: DRDAR-LCB-TL
Watervliet Arsenal, NY 12189

Commander
Man-Machine Integration System
Code 602
Naval Air Development Center
Warminster, PA 18974

Commander
Naval Air Development Center
ATTN: Code 6021 (Mr. Brindle)
Warminster, PA 18974

Commanding Officer
Naval Medical Research
and Development Command
National Naval Medical Center
Bethesda, MD 20014

Director
Army Audiology and Speech Center
Walter Reed Army Medical Center
Washington, DC 20307-5001

COL Carl F. Tyner, MC
Walter Reed Army Institute
of Research
Washington, DC 20307-5100

Commander
U.S. Army Institute
of Dental Research
Walter Reed Army Medical Center
Washington, DC 20307-5300

HQ DA (DASG-PSP-0)
5109 Leesburg Pike
Falls Church, VA 22041-3258

Naval Air Systems Command
Technical Air Library 950D
Rm 278, Jefferson Plaza II
Department of the Navy
Washington, DC 20361

Naval Research
Laboratory Library
Code 1433
Washington, DC 20375

Naval Research Laboratory Library
Shock and Vibration Infor-
mation Center, Code 5804
Washington, DC 20375

Harry Diamond Laboratories
ATTN: Technical Infor-
mation Branch
2800 Powder Mill Road
Adelphi, MD 20783-1197

Director
U.S. Army Human Engineer-
ing Laboratory
ATTN: Technical Library
Aberdeen Proving Ground,
MD 21005-5001

U.S. Army Materiel Systems
Analysis Agency
ATTN: Reports Processing
Aberdeen proving Ground
MD 21005-5017

Commander
U.S. Army Test
and Evaluation Command
ATTN: AMSTE-AD-H
Aberdeen Proving Ground,
MD 21005-5055

U.S. Army Ordnance Center
and School Library
Building 3071
Aberdeen Proving Ground,
MD 21005-5201

Director
U.S. Army Ballistic
Research Laboratory
ATTN: DRXBR-OD-ST Tech Reports
Aberdeen Proving Ground,
MD 21005-5066

U.S. Army Environmental Hygiene
Agency
Building E2100
Aberdeen Proving Ground,
MD 21010

Commander
U.S. Army Medical Research
Institute of Chemical Defense
ATTN: SGRD-UV-AO
Aberdeen Proving Ground,
MD 21010-5425

Technical Library
Chemical Research
and Development Center
Aberdeen Proving Ground,
MD 21010-5423

Commander
U.S. Army Medical Research
and Development Command
ATTN: SGRD-RMS (Ms. Madigan)
Fort Detrick, Frederick, MD 21701

Commander
U.S. Army Medical Research
Institute of Infectious Diseases
Fort Detrick, Frederick,
MD 21701

Commander
U.S. Army Biomedical Research
and Development Laboratory
ATTN: SGRD-UBZ-I
Fort Detrick, Frederick,
MD 21701

Director, Biological
Sciences Division
Office of Naval Research
600 North Quincy Street
Arlington, VA 22217

Defense Technical
Information Center
Cameron Station
Alexandria, VA 22313

Commander
U.S. Army Materiel Command
ATTN: AMCDE-S (CPT Broadwater)
5001 Eisenhower Avenue
Alexandria, VA 22333

U.S. Army Foreign Science
and Technology Center
ATTN: MTZ
220 7th Street, NE
Charlottesville, VA 22901-5396

Commandant
U.S. Army Aviation
Logistics School
ATTN: ATSQ-TDN
Fort Eustis, VA 23604

Director,
Applied Technology Laboratory
USARTL-AVSCOM
ATTN: Library, Building 401
Fort Eustis, VA 23604

U.S. Army Training
and Doctrine Command
ATTN: ATCD-ZX
Fort Monroe, VA 23651

U.S. Army Training
and Doctrine Command
ATTN: Surgeon
Fort Monroe, VA 23651-5000

Structures Laboratory Library
USARTL-AVSCOM
NASA Langley Research Center
Mail Stop 266
Hampton, VA 23665

Aviation Medicine Clinic
TMC #22, SAAF
Fort Bragg, NC 28305

Naval Aerospace Medical
Institute Library
Bldg 1953, Code 102
Pensacola, FL 32508

U.S. Air Force Armament
Development and Test Center
Eglin Air Force Base, FL 32542

Command Surgeon
U.S. Central Command
MacDill Air Force Base
FL 33608

U.S. Army Missile Command
Redstone Scientific
Information Center
ATTN: Documents Section
Redstone Arsenal, AL 35898-5241

Air University Library
(AUL/LSE)
Maxwell AFB, AL 36112

U.S. Army Research and Technology
Labortories (AVSCOM)
Propulsion Laboratory MS 302-2
NASA Lewis Research Center
Cleveland, OH 44135

AFAMRL/HEX
Wright-Patterson AFB, OH 45433

University of Michigan
NASA Center of Excellence
in Man-Systems Research
ATTN: R. G. Snyder, Director
Ann Arbor, MI 48109

John A. Dellinger,
Southwest Research Institute
P. O. Box 28510
San Antonio, TX 78284

Project Officer
Aviation Life Support Equipment
ATTN: AMCPO-ALSE
4300 Goodfellow Blvd.
St. Louis, MO 63120-1798

Commander
U.S. Army Aviation
Systems Command
ATTN: DRSAV-ED
4300 Goodfellow Blvd
St. Louis, MO 63120

Commanding Officer
Naval Biodynamics Laboratory
P.O. Box 24907
New Orleans, LA 70189

U.S. Army Field Artillery School
ATTN: Library
Snow Hall, Room 14
Fort Sill, OK 73503

Commander
U.S. Army Health Services Command
ATTN: HSOP-SO
Fort Sam Houston, TX 78234-6000

U.S. Air Force Institute
of Technology (AFIT/LDEE)
Building 640, Area B
Wright-Patterson AFB, OH 45433

Henry L. Taylor
Director, Institute of Aviation
University of Illinois-
Willard Airport
Savoy, IL 61874

Commander
U.S. Army Aviation
Systems Command
ATTN: DRSAV-WS
4300 Goodfellow Blvd
St. Louis, MO 63120-1798

Commander
U.S. Army Aviation
Systems Command
ATTN: SGRD-UAX-AL (MAJ Lacy)
4300 Goodfellow Blvd., Bldg 105
St. Louis, MO 63120

U.S. Army Aviation Systems Command
Library and Information
Center Branch
ATTN: DRSAV-DIL
4300 Goodfellow Blvd
St. Louis, MO 63120

Federal Aviation Administration
Civil Aeromedical Institute
CAMI Library AAC 64D1
P.O. Box 25082
Oklahoma City, OK 73125

Commander
U.S. Army Academy
of Health Sciences
ATTN: Library
Fort Sam Houston, TX 78234

Commander
U.S. Army Institute
of Surgical Research
ATTN: SGRD-USM (Jan Duke)
Fort Sam Houston, TX 78234-6200

Director of Professional Services
AFMSC/GSP
Brooks Air Force Base, TX 78235

U.S. Air Force School
of Aerospace Medicine
Strughold Aeromedical Library
Documents Section, USAFSAM/TSK-4
Brooks Air Force Base, TX 78235

U.S. Army Dugway Proving Ground
Technical Library
3Bldg 5330
Dugway, UT 84022

Dr. Diane Damos
Department of Human Factors
ISSM, USC
Los Angeles, CA 90089-0021

U.S. Army Yuma Proving Ground
Technical Library
Yuma, AZ 85364

U.S. Army White Sands
Missile Range
Technical Library Division
White Sands Missile Range,
NM 88002

AFFTC Technical Library
6520 TESTG/ENXL
Edwards Air Force Base,
CAL 93523-5000

U.S. Army Aviation Engineering
Flight Activity
ATTN: SAVTE-M (Tech Lib)
Stop 217
Edwards Air Force Base,
CA 93523-5000

Commander
Code 3431
Naval Weapons Center
China Lake, CA 93555

U.S. Army Combat Developments
Experimental Center
Technical Information Center
Bldg 2925
Fort Ord, CA 93941-5000

Aeromechanics Laboratory
U.S. Army Research
and Technical Labs
Ames Research Center,
M/S 215-1
Moffett Field, CA 94035

Commander
Letterman Army Institute
of Research
ATTN: Medical Research Library
Presidio of San Francisco,
CA 94129

Sixth U.S. Army
ATTN: SMA
Presidio of San Francisco,
CA 94129

Director
Naval Biosciences Laboratory
Naval Supply Center, Bldg 844
Oakland, CA 94625

Commander
U.S. Army Aeromedical Center
Fort Rucker, AL 36362

Commander
U.S. Army Medical Materiel
Development Activity
Fort Detrick,
Frederick, MD 21701-5009

Directorate
of Combat Developments
Bldg 507
Fort Rucker, AL 36362

Directorate
of Training Development
Bldg 502
Fort Rucker, AL 36362

Chief
Army Research Institute
Field Unit
Fort Rucker, AL 36362

Commander
U.S. Army Safety Center
Fort Rucker, AL 36362

U.S. Army Aircraft Development
Test Activity
ATTN: STEBG-MP-QA
Cairns AAF
Fort Rucker, AL 36362

Naval Aerospace Medical
Institute Library
Building 1953, Code 102
Pensacola, FL 32508

Commander
U.S. Army Medical Research
and Development Command
ATTN: SGRD-PLC (COL Sedge)
Fort Detrick, Frederick
MD 21701

Chief
Human Engineering Laboratory
Field Unit
Fort Rucker, AL 36362

Commander
U.S. Army Aviation Center
and Fort Rucker
ATTN: ATZQ-T-ATL
Fort Rucker, AL 36362

President
U.S. Army Aviation Board
Cairns AAF
Fort Rucker, AL 36362

Commanding Officer
Harry G. Armstrong Aerospace
Medical Research Lab
Wright-Patterson
Air Force Base, OH 45433